Calhoun: The NPS Institutional Archive

DSpace Repository

Theses and Dissertations | 1. Thesis and Dissertation Collection, all items

1974

Characteristics to evaluate the quality assurance workforce.

Reynolds, Craig Otis.

Monterey, California. Naval Postgraduate School

http://hdl.handle.net/10945/16917

Downloaded from NPS Archive: Calhoun

http://www.nps.edu/library

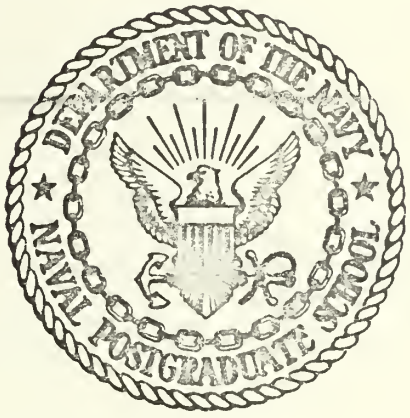
Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

CHARACTERISTICS TO EVALUATE THE QUALITY ASSURANCE WORKFORCE

Craig Otis Reynolds

NAVAL POSTGRADUATE SCHOOL
Monterey, California



THESIS

CHARACTERISTICS TO EVALUATE
THE
QUALITY ASSURANCE WORKFORCE

by

Craig Otis Reynolds

Thesis Advisor: E. A. Zabrycki

Approved for public release; distribution unlimited.

T161745

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Characteristics to Evaluate the Quality Assurance Workforce		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; June 1974 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Craig Otis Reynolds		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE June 1974 13. NUMBER OF PAGES 90
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Quality Assurance is a vital part of any Navy contract administration activity. It is essential that the personnel involved in Quality Assurance be of extremely high caliber. The purpose of this paper is to develop a model of the educational background of an ideal Quality Assurance man. The paper outlines the functions which might be required of each job in the Quality Assurance organization. The model is then developed,

DD FORM 1 JAN 73 1473 (Page 1) EDITION OF 1 NOV 65 IS OBSOLETE S/N 0102-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

and an existing Quality Assurance organization is compared to the model.

The educational backgrounds of personnel are important to their efficient operation. However, other factors are also important. Additional research in the Quality Assurance area is needed.

Characteristics to Evaluate

the

Quality Assurance Workforce

by

Craig Otis Reynolds
Ensign, United States Navy
B.S., United States Naval Academy, 1973

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1974

Thesis
R367
c.1

ABSTRACT

Quality Assurance is a vital part of any Navy contract administration activity. It is essential that the personnel involved in Quality Assurance be of extremely high caliber. The purpose of this paper is to develop a model of the educational background of an ideal Quality Assurance man. The paper outlines the functions which might be required of each job in the Quality Assurance organization. The model is then developed, and an existing Quality Assurance organization is compared to the model.

The educational backgrounds of personnel are important to their efficient operation. However, other factors are also important. Additional research in the Quality Assurance area is needed.

TABLE OF CONTENTS

I. INTRODUCTION---------- 10

A. BACKGROUND---------- 10

B. STATEMENT OF PROBLEMS AND OBJECTIVES-------- 12

C. CONSTRAINTS ON THE PROBLEM---------- 15

D. METHODOLOGY---------- 17

E. OUTLINE---------- 20

II. QUALITY ASSURANCE PRINCIPLES---------- 22

A. DEFINITION---------- 22

B. PURPOSE---------- 22

C. OBJECTIVE---------- 23

D. RESPONSIBILITY---------- 23

III. FUNCTIONS OF A GENERAL QUALITY ASSURANCE ORGANIZATION---------- 25

A. BASIC PRINCIPLES---------- 25

B. FUNCTIONS OUTLINED IN THE ARMED SERVICES PROCUREMENT REGULATIONS---------- 26

C. FUNCTIONS SPECIFIED BY THE DEPARTMENT OF DEFENSE---------- 27

D. QUALITY FUNCTIONS AS DEFINED BY THE CHIEF OF NAVAL MATERIAL---------- 28

E. FUNCTIONS OUTLINED BY THE COMMISSION ON GOVERNMENT PROCUREMENT---------- 28

F. SUMMARY OF FUNCTIONS---------- 29

IV. QUALITY ASSURANCE PERSONNEL---------- 30

A. GENERAL CLASSIFICATIONS OF EXISTING PERSONNEL---------- 30

1. Procurement---------- 30

2. Development---------- 30

3. Supply and Storage---------- 32

4. Maintenance---------- 32

5. Operations---------- 32

6. Manufacturing---------- 33

7. Undistributed---------- 33

B. CLASSIFICATION BY JOB DESCRIPTION---------- 33

1. Quality Assurance/Control Director------ 33

2. Quality Assurance/Control Representative---------- 34

3. Quality Assurance/Control Specialist---------- 34

4. Inspection Specialist---------- 35

5. Inspector---------- 36

6. Engineer---------- 36

7. Statistician---------- 36

V. FUNCTIONAL DESCRIPTION OF REQUIRED PERSONNEL----- 37

A. DOD-WIDE CIVILIAN CAREER PROGRAM MANUAL FOR QUALITY AND RELIABILITY ASSURANCE PERSONNEL---------- 37

B. THE MODEL---------- 40

1. Inspector---------- 40

2. Inspection Specialist---------- 41

3. Quality Assurance/Control Specialist---- 41

4. Quality Assurance/Control Director------ 42

5. Quality Assurance/Control Representative---------- 42

6. Statistician---------- 43

7. Engineer 43

C. SUMMARY OF THE MODEL---------- 43

VI. ANALYSIS OF A NAVAL PLANT REPRESENTATIVE OFFICE AND OF THE MODEL---------- 44

A. GENERAL POLICY AND MISSIONS---------- 46

B. ORGANIZATION---------- 47

1. Quality Program Plans and Requirements Branch---------- 47

2. Quality Engineering Branch---------- 48

3. Reliability Engineering Branch---------- 49

4. Quality Verification Branch---------- 49

C. EVALUATION OF THE PERSONNEL---------- 50

1. Inspectors---------- 50

2. Quality Control Specialists---------- 51

3. Quality Control Director---------- 51

4. Engineer---------- 52

D. SUMMARY OF ANALYSIS---------- 52

E. VALIDITY OF THE MODEL---------- 53

VII. CONCLUSIONS AND RECOMMENDATIONS---------- 54

DEFINITIONS---------- 56

APPENDIX A Quality Assurance Functions---------- 57

APPENDIX B The Model---------- 62

APPENDIX C Drawings---------- 83

LIST OF REFERENCES---------- 87

INITIAL DISTRIBUTION LIST---------- 90

LIST OF TABLES

I. DISTRIBUTION OF MANPOWER IN THE QUALITY ASSURANCE AREA 31

LIST OF FIGURES

1.	THE PROCUREMENT PROCESS	11
2.	SCIENTIFIC METHOD OF INVESTIGATION	18
3.	QUALITY ASSURANCE MAN	38
4.	QUALITY ASSURANCE EDUCATION	45

I. INTRODUCTION

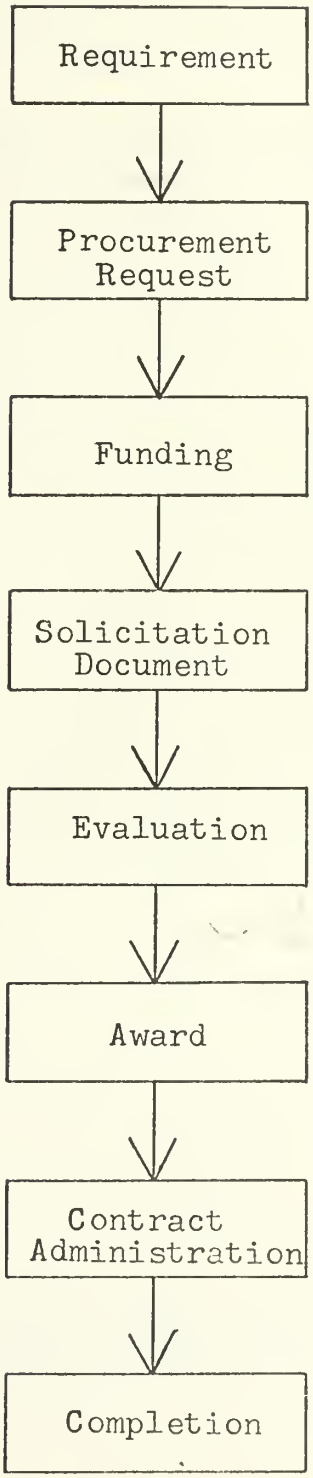
A. BACKGROUND

This paper is concerned solely with Quality Assurance. Therefore it is necessary, at the outset, to establish a workable definition for Quality Assurance. Webster has defined it as ensuring adequate quality in manufactured material. The Department of Defense, in Directive 4155.1, expands on this and defines Quality Assurance as a planned and systematic pattern of all actions necessary to provide adequate confidence that material, data, supplies, and services conform to established technical requirements and achieve satisfactory performance in service [Ref. 5]. With respect to the Government, Armed Services Procurement Regulation 14-001.1 defines Quality Assurance as the Government function by which the Government determines whether a contractor has fulfilled his contract obligations pertaining to quality [Ref. 4]. In general then, Quality Assurance is concerned with the compliance of products and processes to contractual requirements. It is the maintenance of surveillance and performance of inspections to verify conformance to specifications.

Assuring product quality is one of the most important responsibilities of any contract administration activity. This importance is emphasized by the position of the Quality Assurance function in the procurement cycle, as shown in Figure 1 on the following page. The primary area of concentration

FIGURE 1

THE PROCUREMENT CYCLE



of the Quality Assurance effort is the Contract Administration phase. This is the last step before final Government acceptance of material or services. The Quality Assurance function, then, is the last checkpoint the Government has for ensuring that the goods or services conform to contractual requirements, except for latent defects.

B. STATEMENT OF PROBLEMS AND OBJECTIVES

Government procurement is an extremely broad and expensive area of concern. This was underscored by an Office of Management and Budget representative testifying before the Military Operations Subcommittee of the House Committee on Government Operations concerning the vast increase in procurement spending and the far-reaching changes which have occured in the past twenty years. He said, in part, "During this period, the dollar value of procurement awards for supplies and equipment has increased from about $9 billion to about $55 billion."[1] The contribution of the Department of Defense to this figure was pointed out by the Comptroller General of the United States in similar testimony when he stated, "For fiscal year 1968 the Department of Defense alone awarded contracts totaling about $43 billion for supplies and services, representing about eighty percent of total Government procurement expenditures."[2]

---

[1]U.S. Congress, Hearings Before the Military Operations Subcommittee of the House Committee on Government Operations, Government Procurement and Contracting, 91st Congress, 1st Session, March-June 1969, p. 162

[2]Ibid., p. 658.

Several problems have developed in Government contracting. The commission on Government Procurement has noted cost overruns and schedule slippages as significant problems. In addition, Mr. Herbert Roback, Staff Administrator for the Military Operations Subcommittee, has noted an additional problem by stating, in testimony before the Subcommittee, "... the Congress nevertheless receives numerous letters of complaint about material that is shoddy or not working or unusable."[3] Congressman William Dawson, Chairman of the Committee of Government Operations, emphasized this point in a report accompanying the Bill to create the Commission on Government Procurement adding, "The Government procurement organizations and personnel should be improved."[4] The last problem is, by definition by the Secretary of Defense, the responsibility of the Quality Assurance organizations at these procurement activities.

The Quality Assurance organization is one of the most important parts of any contract administration agency. This importance is stressed by Rear Admiral Woodfin, Deputy Chief of Naval Material (Procurement and Production), in the following:[5]

> "The complexity, high cost, and varied mission of current weapon/support systems and their related

---

[3] Government Procurement and Contracting, p. 836.

[4] U.S. Congress, Report to the House Committee on Government Operations, Commission on Government Procurement, 91st Congress, 1st Session, August 12, 1969, p. 2.

[5] Naval Material Instruction 4855.1A, Quality Assurance Policy for the Naval Material Command, January 4, 1974, p. 1.

> equipment require a completely coordinated effort to ensure a high level of operational quality in naval material. The Chief of Naval Material has a responsibility to enhance quality through an effective system for integrating the quality-development, quality-procurement, quality-maintenance, and quality improvement efforts of the Naval Material Command.

Because of these requirements, the Quality Assurance organization must be concerned with cost and time problems as well as technical quality. As a result, there are well over seven thousand personnel involved in Navy Quality Assurance.

Due to the rising cost of Government acquisition there is a natural concern over the number and efficiency of these personnel. The Commission on Government Procurement findings states that many Quality Assurance personnel do not have the abilities, knowledge, and skills necessary to do an adequate job in situations involving complex technology.[6] This is extremely important since, according to the Report, a great deal of the Quality Assurance effort should be in the surveillance of highly technical equipment and procedures. The Commission also found that the training and educational opportunities available to Quality Assurance personnel are inadequate. This need for increased training has been recognized by several Department of Defense sponsored studies [Ref. 7,10].

The Naval Material Command, because of its cognizance over the Navy Quality Assurance functions, is of course interested in determining if it has adequate personnel in

---

[6]Commission on Government Procurement-Study Group #10, Contract Audit and Administration, p. 220, 1972.

this area and in discovering any major areas of weakness.[7] The purpose of this paper is to solve a portion of the above problem. The objectives are to develop a model of the educational requirement of an ideal Quality Assurance man and to test the validity and relevancy of the model. The model describes, in detail, the educational background of a person who could fit into any level of the Quality Assurance organization. In addition, the paper analyzes a current Navy Quality Assurance organization relative to the model and draws conclusions concerning the adequacy of educational backgrounds of the personnel involved.

C. CONSTRAINTS ON THE PROBLEM

To determine the adequacy of Quality Assurance personnel, some measure of effectiveness was needed. However, literary and documentary searches revealed no absolute criteria for evaluation of adequacy. Therefore, some other measure was needed.

There are several characteristics which make up the qualifications of any Quality Assurance person. These characteristics, or variables, include work experience, on-the-job training, personal motivations, and formal education. Since no absolute criteria was available, one, or a combination, of these characteristics had to be evaluated to determine adequacy of personnel. As previously stated, the

---

[7]Telephone interviews with Naval Material Command Quality Assurance personnel, Code 024.

characteristic chosen was formal education. While it was recognized that this was perhaps not the most accurate variable to use in evaluation, it was the most practical. The personal motivation characteristic would be extremely difficult, if not impossible, to quantifiably evaluate. Thus, any evaluation would be equally as difficult. Work experience, although quantifiable, would be extremely time consuming to accurately evaluate. It was felt that formal education was a more accurate and quantifiable characteristic than on-the-job training. In addition, educational background information was readily available. Should there be a high correlation between formal education and personnel adequacy, this would also be the most cost effective evaluation characteristic since little effort would need to be expended in collection and analysis of data. However, the fact that only one characteristic was used in the evaluation was a constraint on the paper.

Another major constraint on the paper was time. Not enough time was available to analyze other characteristics. In addition, only one Quality Assurance organization was utilized in the analysis of the model. Time, in addition to availability of information, was also a factor in restricting the paper to Navy Quality Assurance.

Yet another constraint was that the paper was restricted to Naval Plant Representative Offices and Supervisors of Shipbuilding. The primary reason for this restriction was the technical nature of the Quality Assurance work at these organizations. The principle effort is in the area of new,

recently developed material. Therefore, the educational backgrounds outlined by the model would not be applicable to individuals performing Quality Assurance functions of a less technical nature.

D. METHODOLOGY

The general approach taken in the development of this paper conforms to the procedures outlined by Lee in his book Systems Analysis Frameworks. [Ref. 27] This approach, known as the scientific method of investigation, is outlined in other texts. [Ref. 21, 29] As stated by Lee, the scientific method is ". . . a general process of reasoning based upon judicious trial-and-error and objectivity."[8]

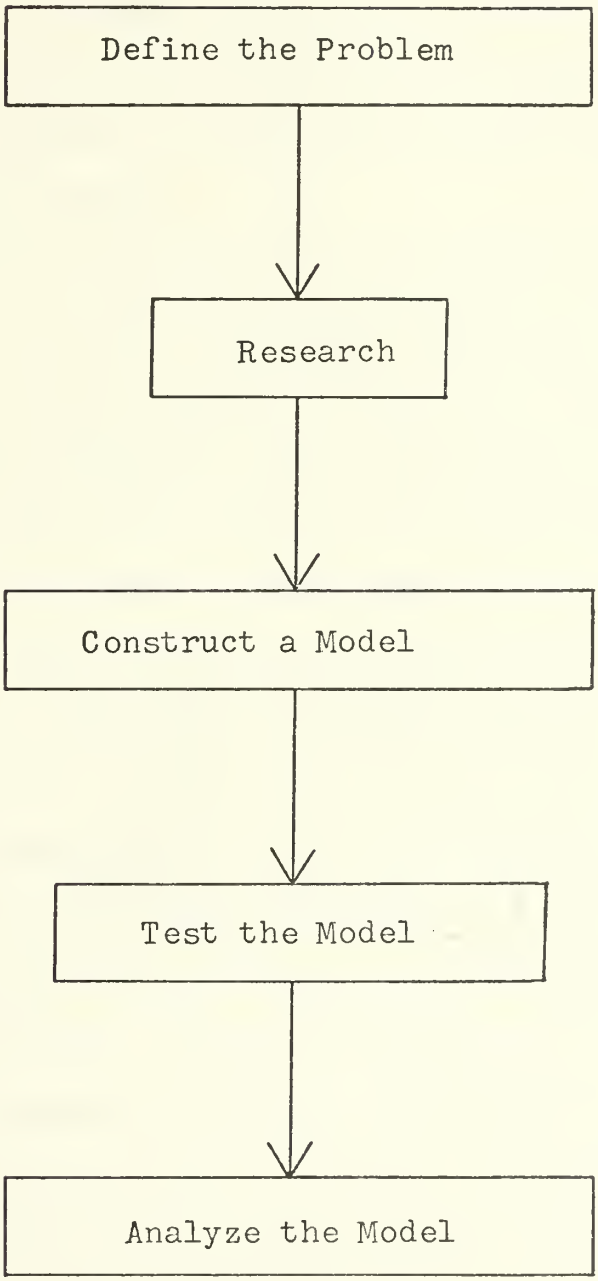
There are five basic steps in the scientific method, shown in Figure 2 on the following page. However, according to Lee, ". . . the application of the method is preceded by an act of problem recognition and appraisal." This problem identification is accomplished in section B of this chapter. As shown in Figure 2, the first step of the scientific method is to narrowly define the problem, or to establish system boundries. These constraints, or boundries, are outlined in section C of this chapter. Lee stresses the importance of narrowing the problem, or system, as much as possible. For this reason, only one variable, education, was examined.

---

[8]Lee, Alec M., Systems Analysis Frameworks, Wiley, 1970, p. 29.

FIGURE 2

SCIENTIFIC METHOD OF INVESTIGATION



Lee, Systems Analysis Framework, 1970.

The second step is the accumulation of relevant data. This was accomplished in four ways--a literary search of published material; a review of Government documents pertaining to Quality Assurance functional and educational requirements; telephone interviews with Quality Assurance personnel; and personal interviews with Quality Assurance personnel. Chapters II, III, and IV are a presentation of this accumulated data.

Sources of information for the paper include Department of Defense, Secretary of the Navy, and Naval Material Instructions and Directives relating to Quality Assurance. Military Specifications on the subject were also investigated. In addition, applicable parts of the Armed Services Procurement Regulation, Report of the Commission on Government Procurement, and Hearings before House and Senate Committees were examined. Department of Defense Quality Assurance education manuals served as the base for the model. Information concerning the Sunnyvale Naval Plant Representative Office was obtained through personal interviews and telephone conversations with Quality Assurance division and branch heads at the Office. Other information in the paper is the result of telephone interviews with and material furnished by Quality Assurance personnel in the Naval Material Command and the Defense Contract Administration Service.

The third step outlined by Lee is to construct a model of the situation. This is done in Chapter V of the paper. The model represents the necessary educational backgrounds

required by the various Quality Assurance responsibilities. This model is intended to be the first step in describing the type of backgrounds required of Quality Assurance personnel. This is the initial effort in developing a model to be used to evaluate the effectiveness of individuals involved in Quality Assurance functions.

The next step of the scientific method is to test the model against actual conditions. The test was made by comparing the Naval Plant Representative Office at Lockheed Missile and Space Company, Sunnyvale, California, to the model. A problem was encountered because there was no absolute way to evaluate whether or not the Sunnyvale Quality Assurance organization was effective. As a result, personal opinions and evaluations of the organization by Quality Assurance personnel at Lockheed Sunnyvale, the Naval Material Command, and the Naval Postgraduate School served as the basis of the test of the validity of the model. While this was not the most reliable method of evaluation, it was felt that this was the best available under the time constraint. This test of the model is shown in Chapter VI.

The final step in the process is to analyze the model. This is done to determine the model's validity. Chapter VI also contains the analysis.

E. OUTLINE

The material presented in this paper is divided into six major sections. The first section is a discussion of some of the basic principles involved in the Quality

Assurance area, including the definition of Quality Assurance itself plus the stated goals and objectives of the Navy Quality Assurance function. In addition, overall responsibility is outlined. This is a very basic section and persons familiar with the Quality Assurance area may find it beneficial to proceed to the next section.

The second section is a composite of functions required of a Quality Assurance organization by various sources, including the Armed Services Procurement Regulations, the Department of Defense, and the Naval Material Command.

Section three is a general description of existing Quality Assurance personnel. First, the general work classifications, as defined by the Department of the Navy, are outlined. Then, the specific job titles for Quality Assurance personnel, as given in the Defense Civilian Career Program Manual, are listed. Finally, some of the general qualification standards and Quality Assurance problem areas are discussed.

The fourth section represents the conceptual model. It is a functional description of the personnel required by a Quality Assurance organization. This description is with respect to the work areas and actual jobs, as previously listed.

Section five is a comparison of the Lockheed Sunnyvale Naval Plant Representative Office Quality Assurance organization with the developed model. The Sunnyvale organization is outlined giving its stated functions, responsibilities,

and the qualifications of its personnel. An evaluation of the organization is made with weak and strong points listed.

The last section is the conclusions and recommendations of this paper.

II. QUALITY ASSURANCE PRINCIPLES

A. DEFINITION

Any study of the Quality Assurance area must begin with a definition of the area of concern. As defined by the Department of Defense Quality Assurance is a planned and systematic pattern of all actions necessary to provide adequate confidence that material, data, supplies, and services conform to established technical requirements and achieve satisfactory performance [Ref. 5]. Taken from the Government's point of view Quality Assurance also means the function by which the Government determines whether a contractor has fulfilled his contract obligations pertaining to quality and quantity. In general then Quality Assurance is concerned with the compliance of products and processes to specifications and contractual requirements.

B. PURPOSE

The primary purpose of Quality Assurance in the Defense Department is the enforcement of technical criteria and requirements governing all material, data, supplies, and services developed, procured, produced, stored, operated, maintained, overhauled, or disposed of by or for any branch of the Department of Defense. Quality Assurance must insure

that all work done for the Defense Department meets pre-established criteria [Ref. 3].

C. OBJECTIVE

The stated objective of the Department of the Navy Quality Assurance Program is that the implementation of Quality Assurance is in direct support of the fundamental objectives of the Department of the Navy. As outlined in Secretary of the Navy Instruction 5400.13 these objectives are to organize, train, equip, prepare, and maintain readiness of Navy and Marine Corps forces and to support such forces, including the support of forces of other military departments as directed by the Secretary of Defense. This support naturally includes the assurance of adequate supplies and equipment. The major thrust of the Department of the Navy Quality Assurance Program is geared to user satisfaction. That is, that the fleets, foreign customers, and other users are provided material which performs satisfactorily or meets contract specifications.

D. RESPONSIBILITY

Overall responsibility for Defense Department Quality Assurance policy guidance has been assigned to the Assistant Secretary of Defense (Installations and Logistics). In addition, a Department of Defense Quality Assurance Council, composed of one General or Flag rank officer and one senior civilian from each of the Military Departments and the Defense Supply Agency, was established. The Council is to provide

consultation and advice to the Assistant Secretary of Defense (Installations and Logistics) on Quality Assurance matters [Ref. 3].

Further responsibility was delegated to each Defense component by requiring that each one designate a central management focal point to be responsible for directing and monitoring Quality Assurance policy compliance with the provisions of Defense Department Directives. Within the Department of the Navy the Secretary of the Navy has designated the Chief of Naval Material, under the Chief of Naval Operations, as the central management focal point. In addition to the above responsibilities the Chief of Naval Material is required to advise and coordinate with other focal points on quality matters which have significant impact on Navy programs [Ref. 15].

The Chief of Naval Material has further delegated the bulk of the Quality Assurance work by issuing the Department of the Navy Management Policy. This policy states that the center-of-gravity of Navy Quality Assurance management is decentralized to subordinate commands below departmental level. The Navy's System Commands, hardware oriented, and their field activities such as Naval Plant Representative Offices and Supervisors of Shipbuilding are considered the action organizations for Quality Assurance. The overall Navy Quality Assurance organization is shown in Appendix C.

III. FUNCTIONS OF A GENERAL QUALITY ASSURANCE ORGANIZATION

The next step in the analysis of a Quality Assurance organization is to define exactly what the organization must do--that is, to state exactly what functions it must perform. Department of Defense Directive 4155.1 does give leeway to separate commands in establishing their Quality Assurance organizations by stating that the degree and type of Quality Assurance provided during the life of a product (from development through disposal) shall be optimally varied to assure mission responsiveness. So while no specific organization is required, there have been several guidelines established. The Department of Defense has stated that any Quality Assurance organization must be able to insure that material, data, supplies, and services conform to specified requirements; that specified requirements for material, data, supplies and services are practical and enforceable; and that user dissatisfaction and mission ineffectiveness are prevented or eliminated [Ref. 3].

A. BASIC PRINCIPLES

The basic Government policy is that the contractors are responsible for controlling product quality and presenting to the Government only items conforming to contractual requirements. In fact there are numerous contract provisions in the area of Quality Assurance and Inspection

which place the quality responsibility directly on the contractor.[9] The Government, of course, does reserve inspection rights. There are several basic principles, established by the Chief of Naval Material, which serve as guidelines for the operation of a Quality Assurance organization. First, quality must be a major factor in weapon system planning, management, and engineering and will be treated in quantitative terms. Next, the inherent quality is established by the basic design and can be improved only by design changes. Also, improvement in design quality is most economically achieved during the early research and development and testing programs. Fourth, assurance of achieved quality requires a planned program throughout the life cycle of the weapon or equipment. Finally, the quality inherent in the design tends to be degraded as a result of variations, deviations, and waivers from the standard in manufacturing, inspection, installation, material handling, packaging, storage, maintenance, transportation, and operation [Ref. 14].

B. FUNCTIONS OUTLINED IN THE ARMED FORCES PROCUREMENT REGULATIONS

While these statements provide general guidelines on Quality Assurance functions, there are several sources of detailed functions. One of these is the Armed Forces Procurement Regulations. Section 1-406 outlines many functions

---

[9]Commission on Government Procurement, p. 208.

that a general Quality Assurance organization must be able to perform if required by a contract. A list of these functions is contained in Appendix A-1. As is evident these functions are rather general in nature. They do, however, define the role a Quality Assurance organization should play.

C. FUNCTIONS SPECIFIED BY THE DEPARTMENT OF DEFENSE

As previously stated there are several sources of Quality Assurance functions. While the Armed Services Procurement Regulations are very broad, the Defense Department has also stated numerous functions it considers imperative to a Quality Assurance organization. Many of these are contained in Department of Defense Directive 4155.1. Some of these functions duplicate those in the Armed Services Procurement Regulations, but others are either modifications or are completely different. These functions are listed in Appendix A-2. Primarily, these functions require more direct involvement--inspection, examination, testing--than do those in the Armed Services Procurement Regulations. This is, however, still consistent with the general policy of the contractor having primary Quality Assurance responsibility with inspection rights reserved for the Government. The Defense Department functions also go further in stressing the early involvement of the Quality Assurance organization in the pre-award evaluation of contracts.

D. QUALITY FUNCTIONS AS DEFINED BY THE CHIEF OF NAVAL MATERIAL

The next source of Quality Assurance functions which are directly applicable to Navy organizations is the Chief of Naval Material. These functions are contained mainly in Naval Material Instruction 4855.1A and the Navy Guide for Contract Managers. These functions are listed in Appendix A-3. It is quite obvious that these functions are much more general then those previously listed. These functions detail very few specific actions to be performed, but instead they state general objectives. There is much less emphasis on actual inspection and testing. There is, however, the same importance placed on early involvement by the Quality Assurance organization. Despite the lack of emphasis on actual inspection, Naval Material Instruction 4855.1A does implement Department of Defense Directive 4155.1 so that the same functions apply.

E. FUNCTIONS OUTLINED BY THE COMMISSION ON GOVERNMENT PROCUREMENT

The last major source of Quality Assurance functions is the Commission on Government Procurement [Ref. 2]. This Commission did a study of the entire procurement process, including Quality Assurance, and listed several functions it considered to be important. A list of the functions is contained in Appendix A-4. While this list is limited, the Commission's lack of emphasis on the inspection function is evident. This appears to be consistent with those functions outlined by the Chief of Naval Material.

F. SUMMARY OF FUNCTIONS

Many of the functions listed are clearly the sole responsibility of the Quality Assurance organization. Such tasks as monitoring contractor reliability programs, reviewing contracts for adequacy of Quality Assurance information, and inspecting in-process and completed products could logically fall to no one else. Other functions, such as review of engineering changes and cost reduction proposals and conduct of pre-award surveys, are clearly responsibilities the Quality Assurance organization shares with other departments, such as Engineering or Industrial, since both have an interest in the outcome of such changes or surveys. Some functions, however, are not as easily identified as Quality Assurance responsibilities. Functions dealing with the financial aspects of the contract could be placed in other departments. But any financial or engineering decisions can seriously impact the work of the Quality Assurance organization, and they therefore should share the responsibility for performance of those functions.

IV. QUALITY ASSURANCE PERSONNEL

A. GENERAL CLASSIFICATIONS OF EXISTING PERSONNEL

There are several methods of classifying Quality Assurance personnel--by area of work, by job description, or by functional specialty. The first classification method to be discussed is by area of work.

The Department of the Navy has established seven categories of distribution of manpower over major areas of Quality Assurance policy [Ref.13]. A list of these areas with numbers and percentage of personnel involved is contained in Table I.

1. Procurement

This area is concerned with the purchasing, receiving, and inspection of material, data, supplies, or services. Quality Assurance personnel are responsible for assuring that contracts specify appropriate quality requirements and that contractors comply with quality requirements. In addition, Quality Assurance personnel must maintain contractor quality history data.

2. Development

Quality Assurance personnel involved in development must provide for the assessment of the quality requirements in relation to cost, schedule, and performance parameters as early as possible. Prior to completion of development personnel must insure that all specifications, standards,

TABLE I

CATEGORIES OF DISTRIBUTION

OF NAVY QUALITY ASSURANCE

MANPOWER*

	AREA	NUMBER	PERCENTAGE
1.	Procurement	1131	14.7
2.	Development	9	0.001
3.	Supply and Storage	179	2.3
4.	Maintenance	4625	60.5
5.	Operations	39	0.003
6.	Manufacturing	982	12.8
7.	Undistributed	693	9.0

*DOD Quality Assurance Overview, January 20, 1973.

tests, inspections, and evaluations required to insure against degradation of performance during the production process are identified and developed. Calibration requirements for newly developed material must also be identified.

3. Supply and Storage

This area involves the receiving, storing, and issuing of supplies. Quality Assurance personnel are responsible for inspection of both new and returned material for identification, condition, completeness, preservation, packing, and marking. Material in storage must also be inspected on a planned, cyclic, surveillance basis. Periodic tests of stored material must also be performed.

4. Maintenance

Maintenance functions include conversion, modification, overhaul, repair, and alteration of material. Quality Assurance personnel are required to monitor all maintenance functions at all levels and insure that each function conforms to requirements.

5. Operations

Quality Assurance personnel are responsible for maintaining the quality of performance and readiness of all equipment at their command. This responsibility includes organizing, equiping, training, and providing such Quality Assurance services as are necessary to insure material readiness.

6. Manufacturing

This area is extremely broad and can include the functions of design, development, fabrication, processing, assembly, installation, packaging, packing, and shipping. Quality Assurance personnel must insure that sufficient management action is taken to plan and develop effective and economical Quality Assurance for material produced. The Quality Assurance must be compatible with the engineering and tooling needs of production and the related design.

7. Undistributed

These are personnel not specifically assigned to any one manpower area. They perform functions which cross two or more lines, such as an Inspector working in both the procurement and maintenance areas.

B. CLASSIFICATION BY JOB DESCRIPTION

The next type of personnel classification to be examined is by job description. This is a classification by the jobs people actually perform and by their responsibilities [Ref. 6].

1. Quality Assurance/Control Director

These are primarily managerial positions. Supervision of other employees is usually inherent. General duties of these positions are to provide the leadership, technical guidance, and direction to a Quality Assurance management program for material procured, received, stored, issued, fabricated, and/or maintained.

2. Quality Assurance/Control Representative

This is a specialty which applies primarily where a person has responsibility for a full sequence of tasks in monitoring an inspection or Quality Assurance system in a plant, facility, or segment of a plant. This generally includes positions responsible for assuring that a contractor is producing an acceptable quality level product when, by terms of the contract, the contractor is held responsible for inspection and control of quality. Quality Assurance is accomplished through surveillance of the contractor's inspection system or surveillance of the contractor's quality control system. The Quality Assurance Representative has responsibility for product acceptance at the contractor's plant and serves as the government representative in dealing with the contractor on matters concerning quality of supplies and services.

3. Quality Assurance/Control Specialist

These are staff specialists located primarily at major commands, intermediate headquarters elements, or Federally operated manufacturing, maintenance, supply, and storage activities.

Personnel in positions of this nature are concerned with the development, installation, or administration of Quality Assurance policies, procedures, plans, programs, or systems to assure an effective system of quality control for material procured, received, stored, issued, fabricated

and/or maintained. Quality Assurance Specialists furnish technical advice and assistance to field commands, installations, and activities, or higher headquarters; and to field representatives, contractors, or other specialists. These personnel review contracts, specifications, drawings, and maintenance and storage requirements to ascertain the complexity of material, quality requirements, performance characteristics, and test requirements. In addition, they also evaluate contractor or in-house quality programs and/or inspection systems and conduct preliminary evaluations surveys of the quality control systems in contractors plants.

4. Inspection Specialist

The principle duties of these personnel are to administer, supervise, or perform work primarily concerned with the development, installation, or administration of inspection procedures, plans, or programs. They also give advice and service to contractors and inspectors in the solution of technical problems arising in connection with inspection, acceptance, and/or rejection of equipment. Inspection Specialists prepare or revise standard inspection plans and procedures to be used in the inspection and acceptance of products. In addition, these personnel develop technical inspection and testing materials for inclusion in contract specifications or program standards. They perform investigations on problems in depot inspections arising from long time storage, maintenance, and reclassification of equipment.

5. Inspector

This classification includes positions in either inspection or quality control programs primarily concerned with actual government inspection and testing of supplies and services to determine compliance with specifications or other requirements when trade, craft, or laboring skills, and knowledges are not paramount qualification requirements. Inspection may be performed during or after fabrication such as in qualification, pre-production, or on raw material, purchased parts, semifabricated components, subassemblies, or end items. Inspectors prepare plans for inspection, recommend approval or disapproval of requests for waivers, and recommend reduced or tightened inspection.

6. Engineer

Engineers are responsible to advise on, administer, supervise, or perform professional, scientific, Quality Assurance, or technical work concerned with engineering or architectural projects, facilities, structures, systems, processes, equipment, devises, quality (including reliability and maintainability), material, or methods.

7. Statistician

The principle duties of Statisticians are to advise on, administer, or perform professional work requiring the design, development, and adaptation of mathematical methods and techniques to statistical processes. In addition, these personnel provide professional consultation in the application of statistical theories, techniques, and methods to the gathering and/or interpretation of quantified information.

V. FUNCTIONAL DESCRIPTION OF REQUIRED PERSONNEL

The next step in the scientific method is to construct the model. This model describes the educational background of a person who would be able to fit into any position in the Quality Assurance organization and perform effectively and efficiently.

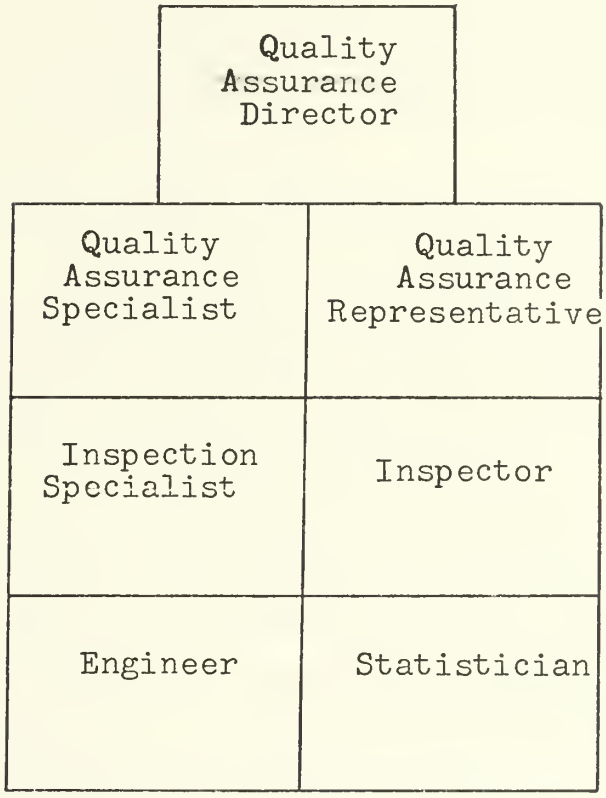
The approach taken in the development of the model was to divide the Quality Assurance man into parts, according to job positions. This relationship is shown in Figure 3 on the following page. Then, the responsibilities of each position were determined from those listed in the Armed Services Procurement Regulations and in Defense and Naval Material Instructions. Next, the educational requirements for each position were developed. The Quality Assurance man then becomes the sum of his parts. The educational requirements needed for a person to fit into any position are the sum of the requirements for each part.

A. DOD-WIDE CIVILIAN CAREER PROGRAM MANUAL FOR QUALITY AND RELIABILITY ASSURANCE PERSONNEL

Any organization is an interaction between the areas of work, the specific jobs performed, and the backgrounds of the personnel comprising that organization. This relationship can be seen in the matrix in Appendix C. The jobs and work areas have already been defined. The next task was to outline the required educational backgrounds. Some base, or

FIGURE 3

QUALITY ASSURANCE MAN



starting point was needed. The Department of Defense has designated the DOD-Wide Civilian Career Program for Quality and Reliability Assurance Personnel as its educational guide by stating in Department of Defense Directive 4155.1 that, "DOD Components shall comply with the DOD-Wide Civilian Career Program for Quality and Reliability Assurance Personnel (DOD Manual 1430.10-m-2) to assure maximum employee efficiency and career growth." [Ref. 6] Therefore, this Manual was chosen as the base.

In general the Manual outlines certain guidelines to be followed in recruitment and hiring of individuals. It emphasizes the need for highly trained personnel by stating, "Intake of highly qualified personnel into the . . . Program is essential to development and maintenance of an effective . . . organization." The Manual also lists three principles of hiring. First, college graduates with good academic qualifications should be recruited. Second, Department of Defense employees who have the necessary qualifications and demonstrated ability to perform effectively should be recruited. Third, organizations may recruit employees from industry or other Federal agencies who possess technical or specialized skills and abilities appropriate to the Quality and Reliability Assurance career field. In addition, the Civilian Career Program Manual outlines the general educational programs necessary for career Quality or Reliability Assurance personnel. This serves as the base of reference for the model.

B. THE MODEL

The general approach to the model was to first list the functional responsibilities or requirements of each job in the Quality Assurance organization. The next step was to list the educational requirements for each position as outlined by the Career Program Manual. The third list is the education requirements based on the general responsibilities of each position and on personal interviews with personnel involved in Quality Assurance, such as Professors and Instructors at the Naval Postgraduate School and department heads at contract administration agencies. The combination of these three lists for all the positions represents the model of the educational background of the ideal Quality Assurance man. These lists are contained in Appendix B.

The requirements as outlined in Appendix B are stated according to educational area. However, educational competence in a particular area was judged according to the degree needed in that area for each position. This was due to the availability of degree information and to the difficulty in evaluating the educational worth of partial degrees.

1. Inspector

The educational background of the Inspector should be technically oriented. He should have a high school education with an Associate's degree in engineering. An additional Associate's degree in the material management field is also required.

The engineering degree is essential since most of the work an Inspector will perform is of a technical nature. The material management degree is also important because of the requirements that an Inspector examine stored material, production processes, and incoming goods. The material management education is the one major area lacking in the Career Program Manual requirements. Little importance is attached to these functions.

2. Inspection Specialist

The educational background of the Inspection Specialist is very similar to that of the Inspector. A basic high school education and Associate's degrees in engineering and material management are required. The Inspection Specialist, however, performs more review functions. As with the Inspector, the Career Program Manual is deficient in the area of material management in its requirements for the Inspection Specialist.

3. Quality Assurance/Control Specialist

The educational requirements for the Quality Assurance Specialist are greater than for previous positions. A Bachelor's degree in engineering is a prerequisite. In addition, a minor or an Associate's degree in material management is required. The advanced engineering degree is necessary because of the large amount of technical review work performed. The additional management degree is essential due to the requirement for review of production, transportation, and inventory functions. The Career Program Manual makes no mention of the requirements for a background in material control.

4. Quality Assurance/Control Representative

As with the Quality Assurance Specialist, the Representative must have a Bachelor's degree in engineering. He is also required to have the minor or Associate's degree in material management. The functions performed in both of these positions are very similar. The Career Program Manual is rather complete in its educational requirements for the Quality Assurance Representative. Only the lack of specification of the level of engineering skill required is evident.

5. Quality Assurance/Control Director

The educational requirements for the Quality Assurance Director are rather extensive. A Bachelor's degree in engineering is still a prerequisite due to the technical nature of the work. A minor or Associate degree in material management is still necessary because of the review functions performed. In addition, however, Masters' degrees in business administration and personnel management are required. The business degree is essential because of the requirement that the Director perform financial review of all Quality Assurance proposals in addition to other review areas. The personnel management degree is necessary because of the leadership position of the Director over the Quality Assurance organization.

The Career Program Manual appears deficient in the business function area. It also fails to stress the importance of the material management education.

6. Engineer

The major thrust of this position is technical work. Therefore, advanced engineering education is essential. A Bachelor's degree in engineering, followed by a specialized Master's degree in engineering is necessary to handle the highly complex work. The manual does outline the need for the engineering background, but fails to emphasize the extent of technical competency required.

7. Statiscian

The Statistician is, quite logically, primarily concerned with mathematics. As a result, a Bachelor's degree in mathematics is essential. In addition, a Master's degree in probability and statistics is necessary because of the proficiency level required. The Career Program Manual defines very well the education background required for Statisticians.

C. SUMMARY OF THE MODEL

As previously stated, the educational requirements for the ideal Quality Assurance man are the sum of all the educational requirements of the various positions. Therefore, this perfect man is required to have a very extensive educational background. A Bachelor's degree in engineering and a Bachelor's degree in mathematics are required. In addition, a minor or Associate's degree in material management is necessary. The ideal Quality Assurance man is also required to have several Master's degrees, including one in business, engineering, personnel management, and mathematics. This

educational background is essential for a person to be able to fit into any level of any position within the Quality Assurance organization.

This model is designed to illustrate the specific educational experiences necessary for the perfect Quality Assurance man. It points out the necessary areas and extent of education required. The approach was to divide the ideal man into parts. Figure 4 on the following page shows the educational requirements of the perfect man by part.

VI. ANALYSIS OF A NAVAL PLANT REPRESENTATIVE OFFICE AND OF THE MODEL

According to Lee, the next step in the scientific method is testing the model (See Figure 2). This test was accomplished by comparing a Naval Plant Representative Office Quality Assurance organization to the model. First, judgements of the educational backgrounds of the personnel in the organization relative to the model were made. Then, the validity of the model was examined by comparing the results of the model test to the actual performance background of the Naval Plant Representative Office. This performance evaluation is based on the opinions of personnel in the Office and of other personnel involved in Quality Assurance.

The approach taken was to examine the educational backgrounds of a certain percentage of the Quality Assurance personnel at the Lockheed Sunnyvale Naval Plant Representative Office. There are one hundred Quality Assurance personnel in the Sunnyvale organization. A sample of twenty-five percent

FIGURE 4

QUALITY ASSURANCE EDUCATION

Q. A. Director
Master's Degree in Personnel Management Master's Degree in Business Bachelor's Degree in Engineering Associate Degree in Material Management

Q. A. Specialist	Q. A. Representative
Bachelor's Degree in Engineering Associate's Degree in Material Management	Bachelor's Degree in Engineering Associate's Degree in Material Management
Inspec. Spec.	**Inspector**
Associate's Degree in Engineering Associate's Degree in Material Management	Associate's Degree in Engineering Associate's Degree in Material Management
Engineer	**Statistician**
Bachelor's Degree in Engineering Master's Degree in Engineering	Bachelor's Degree in Mathematics Master's Degree in Probability

was taken from each branch on a random basis. The backgrounds of these individuals were then compared to the model.

Before presenting the results of the survey and the analysis, the Quality Assurance organization at Sunnyvale is discussed. Section A is a discussion of the general policies and Section B is an outline of the various branches of the organization.

A. GENERAL POLICY AND MISSIONS

The Naval Plant Representative Office is responsible for administering contracts assigned to it. This includes the carrying out of inspection, security, and other related duties for material and services under procurement by the Government. The Quality Assurance Division is just one of several within the Office (Appendix C). It is, however, one of the most important. It is the Quality Assurance Division's responsibility to ensure that all material and services procured meet contract requirements. The Quality Assurance Division has as its stated mission to:

1. direct, coordinate, and monitor the contractor's Quality Assurance programs to ensure conformance with assigned contracts;

2. review and evaluate contract proposals and contract change proposals to ensure that quality and reliability provisions are adequate;

3. direct, coordinate, and monitor the tooling and gaging programs;

4. provide direction, laison, and guidance to the various contractors and supporting government agencies to ensure their proper integration and coordination in matters of quality and reliability in all phases of contract performance;

5. act as advisor to the representative in matters pertaining to quality management.

The importance of the Quality Assurance Division at Lockheed Sunnyvale is even greater because of the unique role of the Office. This Office is responsible for some work done on the Polaris/Poseidon program. The quality and accuracy required under this program are extremely precise.

B. ORGANIZATION

The Quality Assurance Division is directly responsible to the Representative and the Executive Officer of the Naval Plant Representative Office. The Division is composed of four separate branches--Quality Program Plans and Requirements Branch, Quality Engineering Branch, Reliability Engineering Branch, and Quality Verification Branch with Quality Verification being further divided into four sections--Support Equipment, Electronics, Mechanical/Hydraulics, and Ordnance (Appendix C).

1. Quality Program Plans and Requirements Branch

This Branch is composed of seven Quality Control Specialists and one Data Technician. It has responsibility for several of the Quality Assurance functions. The Plans and Requirements Branch plans and directs the Government Quality Assurance programs at the Sunnyvale office and provides guidance and direction to contractors on Government Quality Assurance requirements. It also develops standard operating procedures covering Quality Assurance methods, controls, and divisional operations. This Branch is also responsible for review and approval of contractors' overall

Quality Assurance plans, policies, and procedures, including audits of contractors' programs. Its review functions also extend to contract proposals, to ensure adequate Quality Assurance provisions. The Plans and Requirements Branch must also prepare test/inspection plans and data collection, analysis, and reporting plans.

2. Quality Engineering Branch

The Quality Engineering Branch consists of seven Engineers. Primarily this Branch monitors and directs the contractor's Quality Engineering programs, including design, testing, performance evaluation, modification, production, and operational use. It is also responsible for the material review program. This includes working with the Engineering Division and approving the product quality aspect of the contractors requests for waivers and deviations. Responsibility also includes review of the design disclosure documents program plans and lot acceptance. Considerable effort is also expended in review of contracts and contract change proposals to ensure that quality provisions are appropriately defined. Management of the inspection media program, which includes the final inspection gage program and the special and master tooling program, is also a function of the Quality Engineering Branch. In addition, it directs and monitors the contractor's and Government's efforts in establishment and maintenance of electrical and mechanical standards calibration programs.

As stated by personnel in the organization, typical work would include failure diagnosis, tooling, gaging,

metrology, work with fleet failures, development of test plans, creation of incentive plans, taking corrective action, and proposal review.

3. Reliability Engineering Branch

This Branch is concerned mainly with ensuring the reliability of material produced. It develops and maintains government imposed reliability programs and provides guidance to the contractor on implementing reliability requirements. This is accomplished through review and approval of all reliability plans and documents. The Reliability Engineering Branch is also required to review and evaluate contracts and contract change proposals to ensure they contain sufficient reliability provisions. The surveillance program functions relating to Sunnyvale contracts are also under the Reliability Branch's cognizance. An additional function is to manage and participate in programs and other efforts to advance the state-of-the-art in reliability, maintainability, and non-destructive test techniques.

4. Quality Verification Branch

The last Branch, Quality Verification, is composed of two Quality Control Specialists and seventy Inspectors, making it by far the largest Branch. Its main function is direct product testing and inspection. It also conducts audits of manufacturing processes and procedural requirements versus practices. This Branch is responsible for surveillance inspections of production related operations and for final Government acceptance of material. It must monitor the effectiveness of the contractor's quality verification programs.

The Quality Verification Branch provides recommendations to the contractor and to engineering and quality management personnel relating to manufacturing and production problems affecting quality, cost, or schedules. In addition, this Branch provides surveillance of the contractor's security and safety programs.

C. EVALUATION OF THE PERSONNEL

This section represents the analysis of the Lockheed Sunnyvale personnel educational backgrounds. The comparison was made on a job to job basis. That is, the Quality Assurance man was again broken down into his parts (See Figure 3) and the analysis was made by comparing each job to the applicable part of the ideal Quality Assurance man.

Every job is not represented in the Lockheed Quality Assurance organization. There are no Inspection Specialists or Quality Assurance Representatives listed. There is one Statistician, but the records of this individual were not examined due to the random nature of the sample

1. Inspectors

There are seventy Inspectors within the Quality Assurance organization. All are in the Quality Verification Branch. The records of seventeen Inspectors were examined. All had a basic high school education. However, there were no degrees, Bachelor or Associate. Seven of the individuals had some Associate work, primarily in the engineering and technical areas.

According to the model (See Figure 4), Inspectors are required to have Associate degrees in both engineering and material management, in addition to a high school education. While every Inspector had a high school education, there were no college degrees. It was therefore concluded that the education of the Inspectors was inadequate to effectively perform their required functions.

2. Quality Control Specialists

There are nine Quality Control Specialists in the organization, split between the Plans and Requirements Branch and the Quality Verification Branch. The educational backgrounds of two of these individuals were examined. Both of these men had some college level work, primarily engineering, but there were no Bachelor's degrees.

The model lists the educational requirements of a Quality Control Specialist as being a Bachelor's degree in engineering and an Associate's degree in material management. Since there were no degrees, it was concluded that the educational backgrounds of the Quality Control Specialists were insufficient for them to adequately perform their functions.

3. Quality Control Directors

Within the Quality Assurance Division there are five Quality Control Directors. The record of one of these individuals was examined. The basic engineering degree was present. There was some graduate work completed, but there were no Master's degrees.

Because the model requires Master's Degrees in both personnel management and business, it was concluded

that the education of the Quality Assurance Director was lacking in several areas.

4. Engineers

In the Quality Engineering and Reliability Engineering Branches there are thirteen Engineers. The backgrounds of three of these men were examined. All had a Bachelor's degree in engineering. One of the men had a graduate degree in engineering, with the other two having done some graduate work.

The model requires that Engineers have both Bachelor's and Master's degrees in engineering. While some personnel met these requirements, each Engineer did not have both degrees. It was therefore concluded that the educational backgrounds of the Engineers were inadequate to accomplish their required functions.

D. SUMMARY OF ANALYSIS

Looking at the organization as a whole, it was quite obvious that the personnel did not meet the educational requirements as outlined in the model. In no job did all, or even a majority, of the personnel meet the educational requirements for that position. The conclusions of the comparison were that the personnel were inadequate to meet all of their required responsibilities and that the Quality Assurance organization at Lockheed Sunnyvale was therefore inefficient and ineffective.

E. VALIDITY OF THE MODEL

It was the conclusion of the test that the Lockheed Sunnyvale Quality Assurance organization was inefficient. This conclusion was not consistent with previous reports about the organization from Lockheed Quality Assurance personnel. Therefore, additional interviews were conducted with Branch heads at Lockheed Sunnyvale, with Naval Material Command Quality Assurance personnel, and with Professors at the Naval Postgraduate School concerned with Quality Assurance. All felt that the Quality Assurance organization at Lockheed Sunnyvale was more efficient than the model indicated.

It was necessary to ascertain any probable causes for the impreciseness in the model. From the interviews it became obvious that one of the primary causes was that the model evaluated the organization on the basis of only one variable, formal education. Factors such as previous work experience, training courses, and personal motivations had been excluded from the study. Branch heads at Lockheed Sunnyvale indicated that work experience was one of the primary considerations in hiring. In addition, there is a training program at Lockheed Sunnyvale to familiarize personnel with areas in which they have no formal education.

VII. CONCLUSIONS AND RECOMMENDATIONS

The major conclusion of this paper is that some method is needed to evaluate the adequacy of personnel working in the Quality Assurance area. This model represents the first step toward the development of such a method. It outlines the formal education requirements for the various Quality Assurance positions. As was shown, this model is not sufficient to adequately evaluate personnel. It is therefore recommended that further study be conducted in this area. The model should be expanded to include work experience and job training. These additional factors are essential if a tradeoff model is to be developed that can accurately evaluate Quality Assurance personnel.

It is also concluded that, at present, there is no adequate method to objectively evaluate the overall performance of a Quality Assurance organization. It is therefore recommended that research be done in this area.

As is evident from the Introduction, Quality Assurance is of major importance in the procurement process. The need to improve the quality of Government Quality Assurance personnel has already been pointed out. The first step in improving the caliber of individuals hired must be to determine precisely what type of person is needed. While formal education is important, other factors are also involved. The scope of this paper has been limited by time. However,

because of the importance of its objective, additional research into these other areas is highly recommended.

DEFINITIONS

A. Latent Defect - A flaw or other imperfection in an article discovered after delivery to the Government. Such defects are inherent weaknesses which are present at time of manufacture and are aggravated by use.

B. Quality - The composite of material attributes including performance.

C. Inherent quality - The presence in the design of the attributes necessary to accomplish fleet requirements.

D. Achieved quality - The ability of a manufactured item to satisfy a fully substantiated and accurately defined fleet need which the item was conceived to fill.

E. Metrology - The science of measurement for determination of conformance to technical requirements including the development of standards and systems for absolute and relative measurements.

F. Calibration - Comparison of a standard or measuring equipment instrument with a standard of higher accuracy to insure that the former is within specified limits throughout its entire range.

Appendix A Quality Assurance Functions

Appendix A-1

ARMED SERVICES PROCUREMENT REGULATIONS

1. review and evaluate contractor's quality assurance proposals and furnish comments and recommendations to the procuring contracting officer;
2. review, approve, and maintain surveillance of the contractor's procurement system;
3. conduct post-award orientation conferences;
4. perform screening, redistribution, and disposal of contractor inventory;
5. perform production support, surveillance, and status reporting;
6. perform pre-award surveys;
7. perform industrial readiness and mobilization production planning field surveys and schedule negotiations;
8. review the adequacy of the contractor's traffic operations;
9. review and evaluate preservation, packaging, and packing;
10. provide surveillance of contractor design, development, and production engineering efforts;
11. review engineering studies, design, and proposals and make recommendations to the project manager;
12. evaluate and monitor contractor engineering efforts and expenditures;
13. conduct surveillance of contractor engineering practices with regard to subcontractors;

14. review contractor test plans and directives for compliance with contract terms;
15. assist in classification of waivers and deviations;
16. evaluate the adequacy of contractor engineering data control systems;
17. monitor contractor value engineering programs;
18. review cost reduction proposals, and submit comments on effect of proposed changes;
19. evaluate and perform surveillance of contractor configuration management systems and procedures;
20. perform surveillance of contractor engineering change system; review engineering change proposals; assist in price analysis of changes;
21. evaluate the contractor management, scheduling, planning, and allocation of engineering resources;
22. evaluate and monitor contractor reliability and maintainability programs;
23. review and evaluate for technical adequacy the logistic support, maintenance, and modification programs of the contractor;
24. inform purchasing officer of inadequacies in specifications;
25. perform procurement quality assurance;
26. assure contractor compliance with safety requirements;
27. assure timely submission of required reports;
28. when authorized by purchasing office, issue amended shipping instructions; and
29. approve contractor acquisition of special test equipment.

Appendix A-2

DEPARTMENT OF DEFENSE

1. translation of functional requirements into quantitative requirements;
2. insure contracts specify appropriate quality assurance requirements early in the process with respect to cost, schedule, and performance;
3. identify necessary tests, specifications, standards, and inspection requirements;
4. review and improve quality of technical criteria and data;
4. review and monitor contractor procedures, processes, and records;
6. feedback relevant information;
7. maintain contractor quality history data;
8. review contractor decisions with respect to quality assurance;
9. conduct quality audits of material, data, supplies, and services;
10. monitor in-house maintenance functions;
11. conduct pre-production testing;
12. conduct direct product examination and testing of work in process as well as end products;
13. correct and prevent deficiencies and their causes;
14. inspect incoming and stored material; and
15. provide metrology and calibration service.

Appendix A-3

CHIEF OF NAVAL MATERIAL

1. measurement of achieved quality;
2. collection, analysis, and feedback of information;
3. identification, analysis, and control of quality costs;
4. assure Technical Data Packages pay adequate attention to Quality Assurance;
5. insure maintenance quality requirements are included in design and development;
6. take required corrective action; and
7. evaluate and monitor the contractor's overall Quality Assurance program.

Appendix A-4

COMMISSION ON GOVERNMENT PROCUREMENT

1. statistical sampling;
2. results charting;
3. setting control limits;
4. technical surveillance of contractor;
5. approval and review of engineering change procedures and proposals; and
6. general inspections.

Appendix B The Model

INSPECTOR RESPONSIBILITIES

1. Monitor maintenance functions
2. Conduct pre-production testing
3. Conduct direct product examination and testing of work in process and end products
4. Inspect incoming and stored material
5. Collect technical information
6. Assist in classification of waivers and deviations
7. Inspect preservation, packaging, and packing efforts
8. Prepare plans for inspections
9. General inspection
10. Assure timely submission of required reports

INSPECTOR EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Basic Math

Sampling Procedures

Inspection Planning

Measurement and Control

Data Handling

Sensory Measurements

Inspection

Test Engineering

Automation

Reliability

Production Methods

Measuring Gages and Equipment

Contract Terms

INSPECTOR EDUCATIONAL REQUIREMENTS

AS DEFINED BY THE MODEL

Basic Math

Inspection Principles

Measuring Gages and Equipment

Data Handling

Measurement and Control

Automation

Electrical Engineering

Mechanical Engineering

Production Methods

Material Handling

Inventory Control

Test Engineering

Computers

INSPECTION SPECIALIST RESPONSIBILITIES

1. Review and evaluate contractor inspection procedures, plans, and programs
2. Perform pre-award surveys of contractor inspection systems
3. Evaluate proposals for acquisition of special test equipment
4. Identify necessary tests, specifications, standards, and inspection requirements
5. Review and improve quality of technical criteria and data
6. Correct and prevent deficiencies and their causes
7. Supervise general inspection
8. Provide technical advice to contractor on inspection/acceptance problems
9. Assure timely submission of required reports

INSPECTION SPECIALIST EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Statistical Quality Control

Basic Math

Inspection Planning

General Management Orientation

Program Evaluation

Measurement and Control

Data Handling

Inspection

Reliability

Automation

Test Engineering

Sensory Measurement

Control Terms

Production Methods

Measuring Gages and Equipment

INSPECTION SPECIALIST EDUCATIONAL REQUIREMENTS AS DEFINED BY THE MODEL

Basic Math

Inspection Principles

Inspection Planning

Test Engineering

Program Evaluation

Automation

Computers

Measuring Gages and Equipment

Production Methods

Inventory Management

Material Control

Basic Personnel Management

Data Handling

Contract Terms

Mechanical Engineering

Electrical Engineering

QUALITY ASSURANCE/CONTROL SPECIALIST RESPONSIBILITIES

1. Evaluate all contractor Quality Assurance proposals and furnish recommendations
2. Review, approve, and maintain surveillance of the contractor's procurement system
3. Perform screening, redistribution, and disposal of contractor inventory
4. Review adequacy of contractor traffic operations
5. Evaluate preservation, packaging, and packing
6. Perform planning field surveys
7. Monitor contractor value engineering programs
8. Review engineering drawings and specifications
9. Review cost reduction proposals
10. Perform surveillance of contractor configuration management systems and procedures
11. Evaluate contractor scheduling, planning, and allocation of engineering resources
12. Review and evaluate the logistic support, maintenance, and modification programs
13. Evaluate contractor reliability and maintainability programs
14. Maintain contractor quality history data
15. Conduct quality audits of material, supplies, and services

QUALITY ASSURANCE/CONTROL SPECIALIST

EDUCATIONAL REQUIREMENTS OUTLINED

IN THE CAREER PROGRAM MANUAL

Basic Math

Design Engineering

Value Engineering

Program Evaluation

Management Orientation

Work Planning and Control

Supervisory Development

Financial Management

Economic Analysis

Reliability Management

Inspection Procedures

Production Methods

Industrial Engineering

Statistical Analysis

Sampling Principles

Product Engineering

Quality Control Principles

Incentive Plans

Operations Analysis Techniques

Maintainability

QUALITY ASSURANCE/CONTROL SPECIALIST

EDUCATIONAL REQUIREMENTS

AS DEFINED BY THE MODEL

Basic Math

Design Engineering

Value Engineering

Product Engineering

Industrial Engineering

Mechanical Engineering

Electrical Engineering

Financial Management

Reliability Management

Production Management

Material Management

Economic Analysis

Inspection Principles

Operations Analysis Techniques

Quality Control Principles

Contract Terms

Supervisory Development

Work Planning

Program Evaluation

Procurement Principles

QUALITY ASSURANCE/CONTROL REPRESENTATIVE RESPONSIBILITIES

1. Evaluate and monitor the contractor's overall Quality Assurance program
2. Identification, analysis, and control of quality costs
3. Review and approval of engineering change procedures and proposals
4. Review, approve, and maintain surveillance of contractor procurement systems
5. Evaluate preservation, packaging, and packing
6. Review contractor traffic operations
7. Perform screening of contractor inventory
8. Evaluate contractor reliability and maintainability programs
9. Conduct quality audits of material, supplies, and services
10. Monitor contractor value engineering programs
11. Identify necessary tests, specifications, standards, and inspection requirements
12. Perform production support, surveillance, and status reporting
13. Perform surveillance of contractor configuration management systems and procedures
14. Review and evaluate the logistic support, maintenance, and modification programs

QUALITY ASSURANCE/CONTROL REPRESENTATIVE EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Basic Math

Design Engineering

Industrial Engineering

Value Engineering

Product Engineering

Statistical Analysis

Financial Management

Business Economics

Supervisory Development

Work Planning and Control

Procurement Management

Statistical Procedures

Sampling Principles

Operations Analysis Techniques

Quality Assurance Principles

Management Orientation

Work Simplification

Quality Control System Review

Maintainability

QUALITY ASSURANCE/CONTROL REPRESENTATIVE

EDUCATIONAL REQUIREMENTS

AS DEFINED BY THE MODEL

Basic Math

Mechanical Engineering

Electrical Engineering

Design Engineering

Product Engineering

Industrial Engineering

Value Engineering

Financial Management

Business Economics

Procurement Management

Production Management

Material Management

Quality Control Systems Review

Quality Assurance Principles

Supervisory Development

Inspection Principles

Work Planning

Operations Analysis Techniques

Contract Terms

Program Evaluation

QUALITY ASSURANCE/CONTROL DIRECTOR RESPONSIBILITIES

1. Supervise the Quality Assurance effort
2. Provide leadership and technical guidance to the Quality Assurance management program
3. Review and evaluate contractor Quality Assurance proposals
4. Conduct post-award orientation conferences
5. Determine classification of waivers and deviations
6. Insure maintenance quality requirements are included in design and development
7. Set control limits
8. Approve cost reduction proposals
9. Insure contracts specify appropriate Quality Assurance requirements early in the process with respect to cost, schedule, and performance

QUALITY ASSURANCE/CONTROL DIRECTOR EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Financial Management

Personnel Management

Quantitative Decision Making

Organizational Concepts

Business Economics

Procurement Management

Contract Interpretation

Inspection Methods

Oral and Writing Skills

Quality Control Procedures

Production Techniques

Industrial Processes

Quality Control Administrative Techniques

Operations Research Methods

Industrial Engineering

Availability

Maintainability

QUALITY ASSURANCE/CONTROL DIRECTOR

EDUCATIONAL REQUIREMENTS

AS DEFINED BY THE MODEL

Personnel Management

Procurement Management

Financial Management

Business Economics

Material Management

Production Management

Quality Control Procedures

Quality Control

Administrative Techniques

Industrial Engineering

Mechanical Engineering

Electrical Engineering

Value Engineering

Design Engineering

Contract Interpretation

Inspection Principles

Operations Research Methods

Inventory Control

Organization Concepts

ENGINEER RESPONSIBILITIES

1. Evaluate and monitor contractor engineering efforts and expenditures
2. Review engineering studies, designs, and proposals and make recommendations
3. Translate functional requirements into quantitative requirements
4. Advise on, supervise, or perform technical work on architectural projects, facilities, or structures
5. Administer or perform professional, engineering, scientific, or technical work on processes, equipment, or devices
6. Review and approval of engineering changes
7. Technical surveillance of the contractor
8. Conduct surveillance of contractor engineering practices with regard to subcontractors

ENGINEER EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Specification Indoctrination

Inspection Principles

Quality Control Procedures

Chemical Properties

Structural Properties

Dynamic Properties

Physical Properties

Test Engineering

Maintainability

Industrial Engineering

Design Engineering

ENGINEER EDUCATIONAL REQUIREMENTS AS DEFINED BY THE MODEL

Mechanical Engineering

Electrical Engineering

Design Engineering

Industrial Engineering

Aerospace Engineering

Material Properties

Maintainability

Specification Indoctrination

Inspection Principles

Quality Control Principles

STATISTICIAN RESPONSIBILITIES

1. Statistical sampling
2. Results charting
3. Provide assistance in the interpretation of quantified information
4. Advise on or administer work requiring the design, development, or adaptation of mathematical methods to statistical processes
5. Provide consultation on the application of statistical theories, techniques, and methods to gathering of information
6. Monitor contractor reliability data

STATISTICIAN EDUCATIONAL REQUIREMENTS OUTLINED IN THE CAREER PROGRAM MANUAL

Control Charts

Process Control Requirements

Principles of Sampling

Censuses and Surveys

Theory of Estimation

Distribution Functions

Probability Theory

Transformations

System Reliability Analysis

Prediction Theory

Value Analysis

Statistical Inference

Tolerances

STATISTICIAN EDUCATIONAL REQUIREMENTS

AS DEFINED BY THE MODEL

Control Charts

Process Control Requirements

Principles of Sampling

Censuses and Surveys

Theory of Estimation

Distribution Functions

Probability Theory

Transformations

System Reliability Analysis

Prediction Theory

Value Analysis

Statistical Inferences

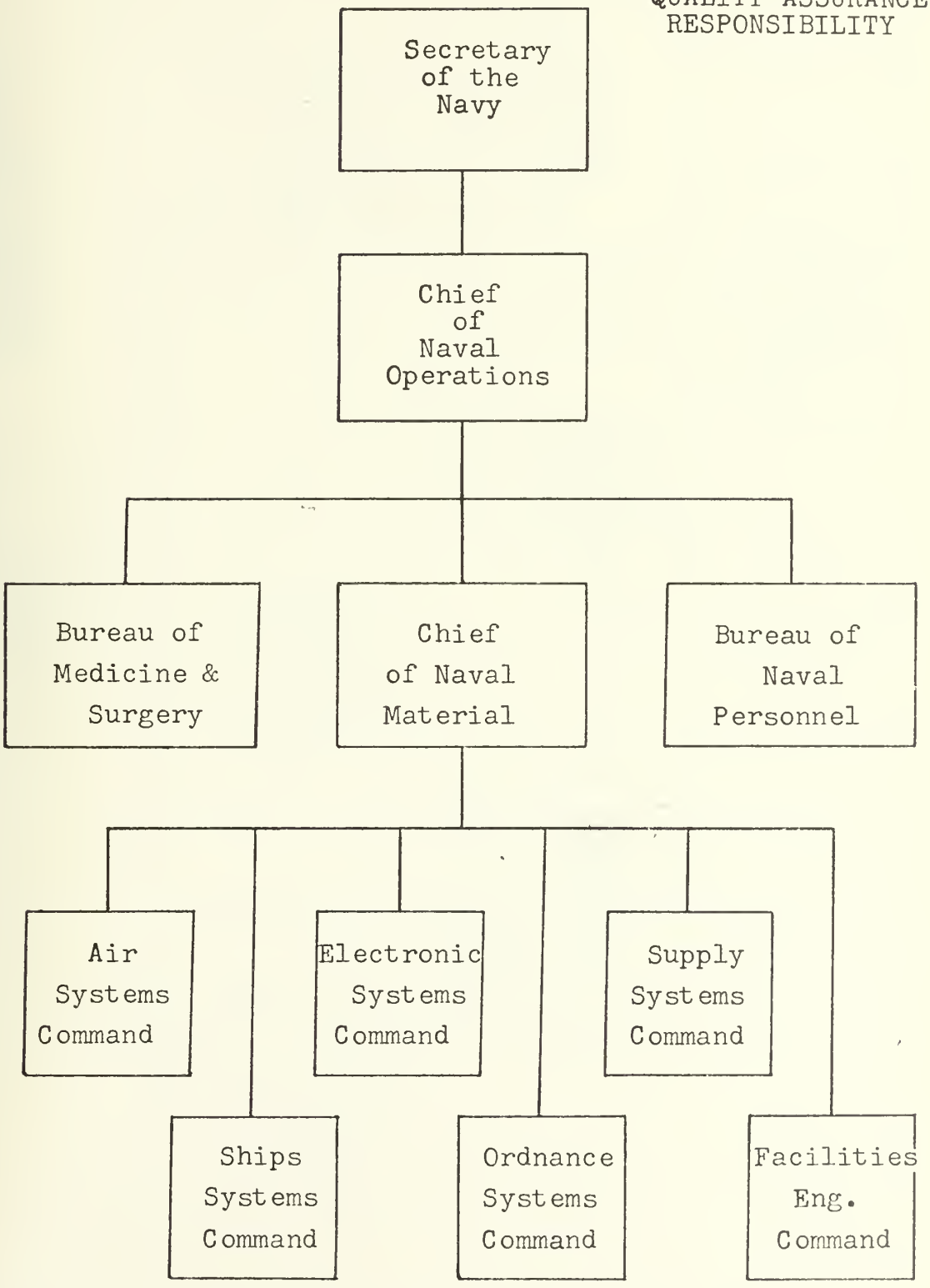
Tolerances

Inspection Principles

Quality Control Principles

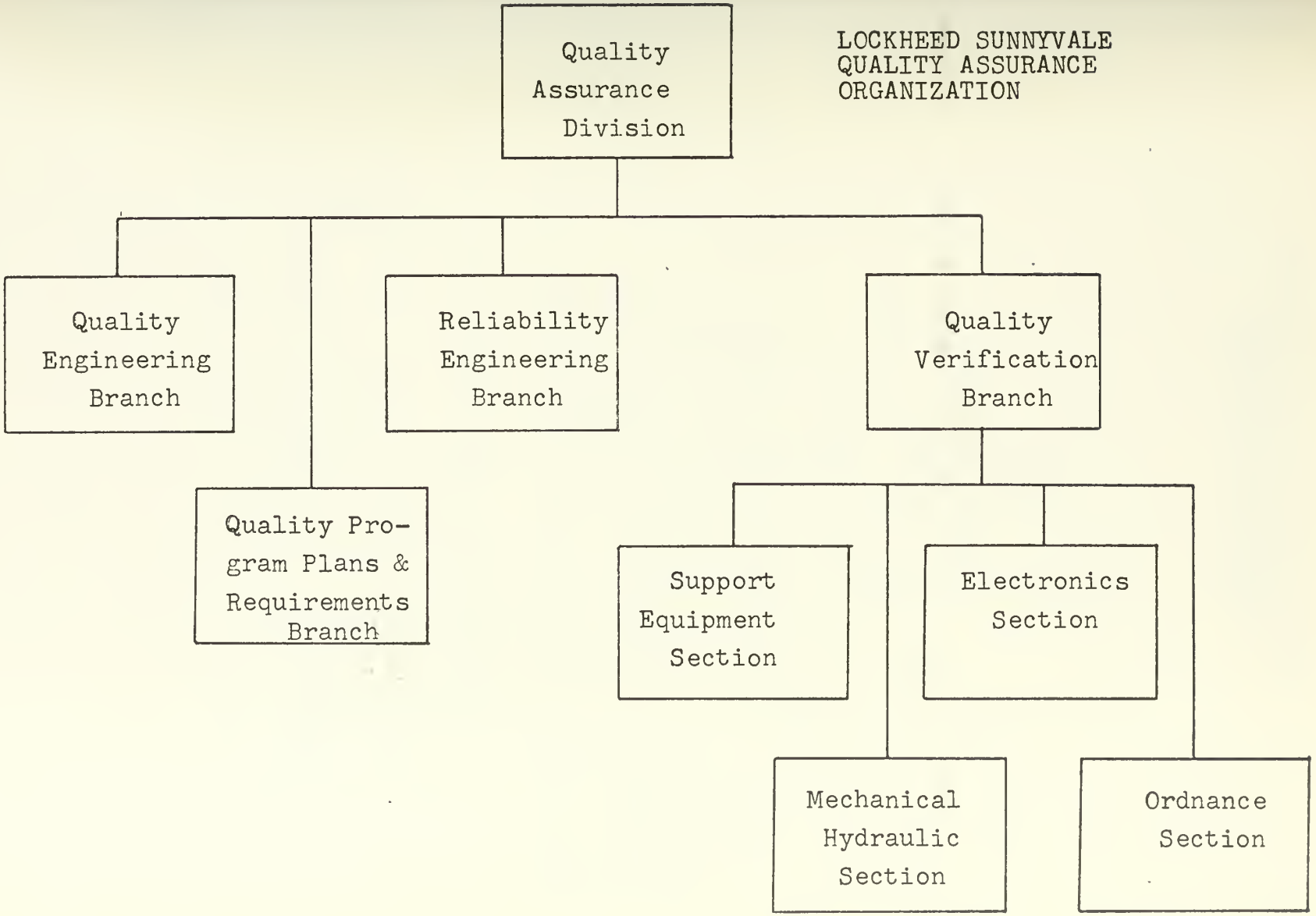
APPENDIX C DRAWINGS

ORGANIZATION FOR NAVY QUALITY ASSURANCE RESPONSIBILITY

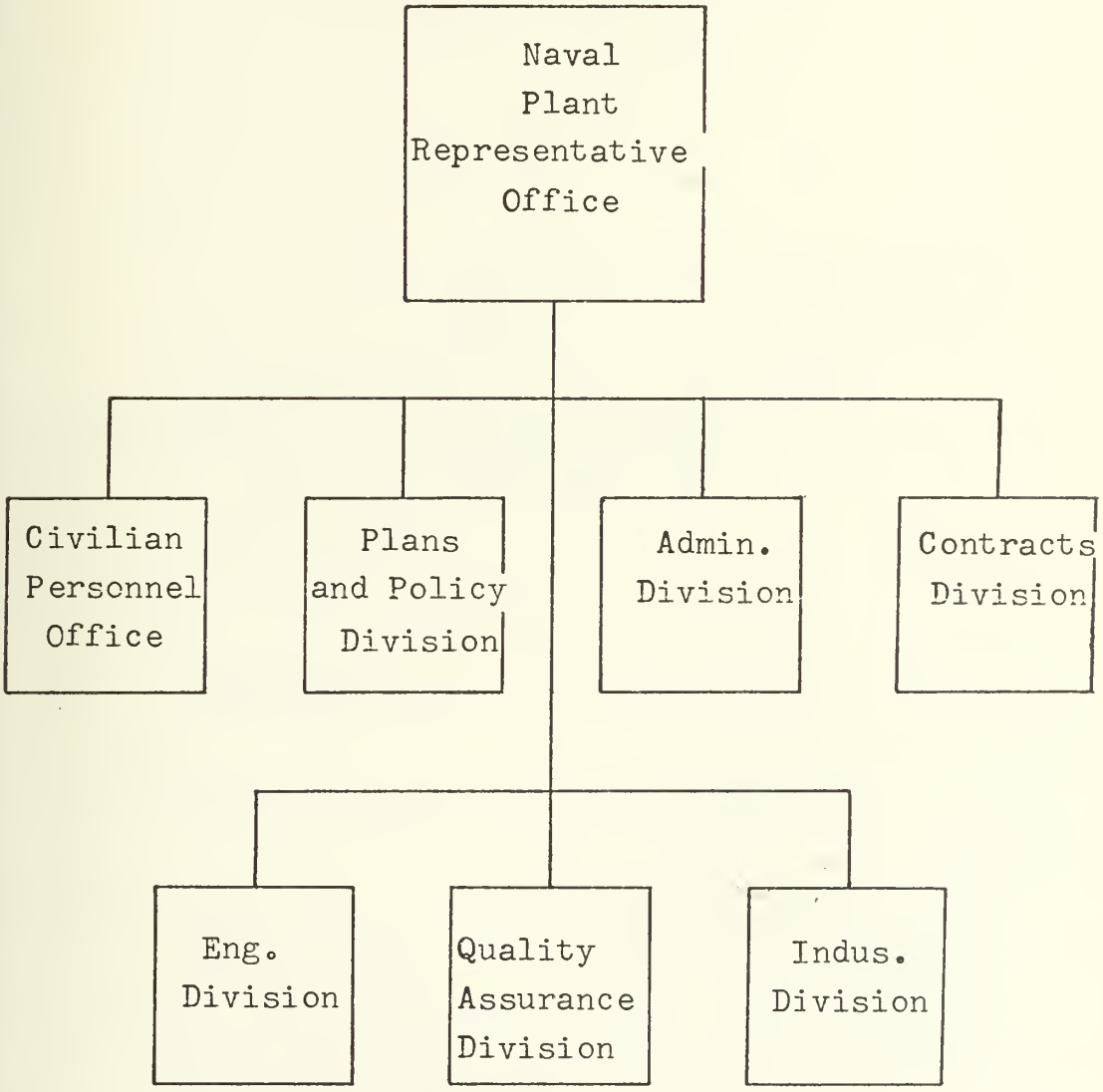


DOD Quality Assurance Overview, 20 January 1973.

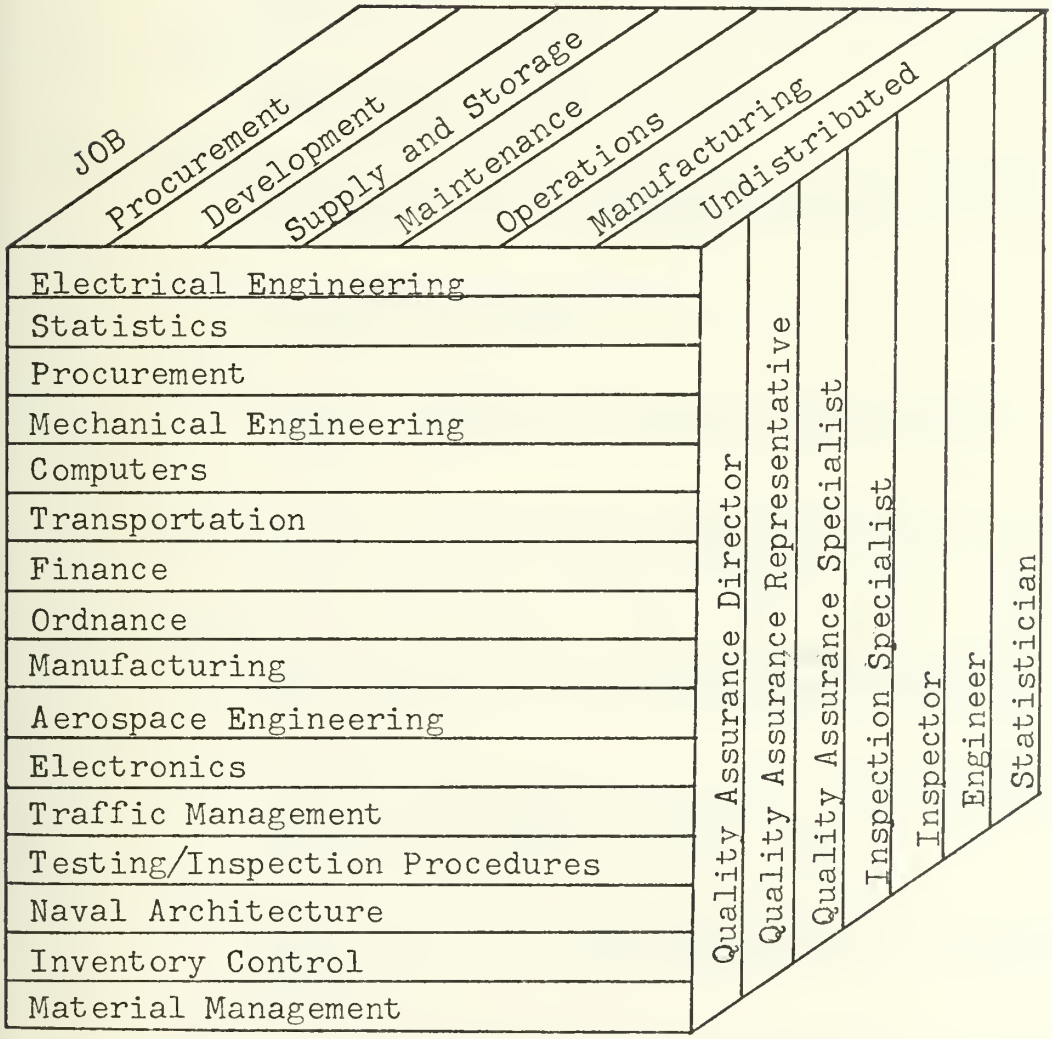
LOCKHEED SUNNYVALE
QUALITY ASSURANCE
ORGANIZATION



LOCKHEED SUNNYVALE NAVAL PLANT
REPRESENTATIVE OFFICE
ORGANIZATION CHART



WORK RELATIONSHIP MATRIX



FUNCTIONAL BACKGROUND

LIST OF REFERENCES

1. Buffa, Elwood S., Models for Production and Operations Management, Wiley, 1963.

2. Commission on Government Procurement - Study Group # 10, Contract Audit and Administration, p. 203-248.

3. Covino, Charles P., and Meghri, Angelo W., Quality Assurance Manual, Industrial Press, 1962.

4. Department of Defense, Armed Services Procurement Regulations, Rev. 12, 16 April 1973.

5. Department of Defense Directive 4155.1, Quality Assurance, 9 February 1972.

6. Department of Defense, DOD-Wide Civilian Career Program for Quality and Reliability Assurance Personnel, (1430.10-M-2), 3 February 1970.

7. Department of Defense Management Conference, Impact '73, 18 February 1968.

8. Department of Defense Military Specification MIL-I-45208A, Inspection System Requirements, 16 December 1963.

9. Department of Defense Military Specification MIL-Q-9858A, Quality Program Requirements, 16 December 1963.

10. Department of Defense, Proceedings Defense Conference on Quality and Reliability Management, Vol. I and II, 1966.

11. Department of Defense Quality and Reliability Assurance Handbook H-50, Evaluation of a Contractor's Quality Program, 23 April 1965.

12. Department of Defense Quality and Reliability Assurance Handbook H-57, Procurement Quality Assurance, June 1969.

13. Department of Defense, Quality Assurance Overview, 20 January 1973.

14. Department of the Navy, Navy Procurement Directives, Rev. 9, 1 September 1971.

15. Enrick, Norbert Lloyd, Inventory Management, Chandler, 1968.

16. Enrick, Norbert Lloyd, Quality Control, Machinery Publishing, 1960.

17. Feigenbaum, Armand V., Total Quality Control, McGraw-Hill, 1961.

18. Greene, James H., Production and Inventory Control Handbook, McGraw-Hill, 1970.

19. Hansen, Bertrand L., Quality Control: Theory and Applications, Prentice-Hall, 1963.

20. Harris, Douglas H., and Chaney, Frederic B., Human Factors in Quality Assurance, Wiley, 1969.

21. Houlden, B. T., Some Techniques of Operational Research, English University Press, 1962.

22. Juran, Joseph M., Seder, Leonard A., and Gryna, Frank M., Jr., Quality Control Handbook, McGraw-Hill, 1962.

23. Kaufman, Arnold, Methods and Models of Operations Research, Prentice-Hall, 1963.

24. Kirkpatrick, Elwood G., Quality Control for Managers and Engineers, Wiley, 1970.

25. Koepke, Charles A., Plant Production Control, Wiley 1961.

26. Kopperman, Ralph, Model Theory and Its Applications, Allyn and Bacon, 1972.

27. Lee, Alec M., Systems Analysis Frameworks, Wiley, 1970.

28. Lee, Lamar, and Dobler, Donald W., Purchasing and Materials Management, McGraw-Hill, 1971.

29. Moore, Peter G., Basic Operational Research, Pitman, 1968.

30. Naval Material Instruction 4855.1A, Quality Assurance Policy for the Naval Material Command, 4 January 1974.

31. Robertson, A. G., Quality Control and Reliability, Nelson, 1971.

32. Secretary of the Navy Instruction 4355.14, Quality Assurance, 7 August 1972.

33. Solmon, Lewis C., and Taubman, Paul J., Does College Matter, Academic Press, 1973.

34. U. S. Congress, House Committee on Government Operations, Commission on Government Procurement, August 12, 1969.

35. U. S. Congress, House Committee on Government Operations, Government Procurement and Contracting, April 15, 16, 21, 22, and 28, 1969.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Department Chairman, Code 55 Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
4.	LCDR E. A. Zabrycki, USN, Code 55 ZX Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	ENS Craig Reynolds, USN Post Office Box 66 Purcell, Oklahoma 73080	1

153114
Thesis
R367 Reynolds
c.1 Characteristics to evaluate the quality assurance workforce.
21 SEP 79 26040
28 NOV 80 27038
30 OCT 86 31144

153114
Thesis
R367 Reynolds
c.1 Characteristics to evaluate the quality assurance workforce.

thesR367
Characteristics to evaluate the quality
3 2768 002 01325 2
DUDLEY KNOX LIBRARY